next-CSP

High Temperature concentrated solar thermal power plant with particle receiver and direct thermal storage

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Deliverable D8.2

WP8 – WP Environmental assessment of the technology

Deliverable D8.2 Report on the evaluation of the environmental footprint changes due to Next-CSP system relative to the standard system

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Nomenclature

ATS	Advanced Thermal System	LCOE	Levelised Cost of Energy
CSP	Concentrated Solar Power	LMs	liquid metals
DCB	Dichlorobenzene	NRE	Non-renewable energy
DNI	Direct Normal Irradiance	NREs	Non-Reviewable Energies
EPBT	Energy Payback Time	PV	Photovoltaic
EP	Eutrophication potential	SEC	Solar Energy Conversion
GHGs	Green House Gases	SPT	Solar Power Tower
GWP	Global Warming Potential	STPP	Solar Thermal Power Plant
HTFs	heat transfer fluids	STWT	Solar Thermal Wind Tower
ISEGS	Ivanpah Solar Electric Generating System	SEDC	Solar Energy Development Centre
LBE	Pb-Bi eutectic	USSE	Utility-Scale Solar Energy
LCA	Life Cycle Assessment	WoS	Web of Science

1 Comparison against other technologies

1.1 Aim of this deliverable

Solar power towers (SPTs) are emerging concepts that have been developed to produce solar energy by focusing the sunlight and converting it to other forms of energy such as heat and electricity. Although such installations generate green energy without any need (or limited amount) of fossil fuel consumption, they may bring some environmental impacts. Minimization of such impacts together with optimization of other sustainability pillars such as enhancing the SPTs performance, reducing the attributed costs and making such installations more socially acceptable can potentially aid for their wider commercialization. In this regard, it has been aimed in this study to present a description of the solar energy collection, conversion and storage principles and the recent advances that have occurred in this field as well as the main environmental impacts observed for such installations according to the life cycle assessment (LCA) studies performed on the constructed, under construction and SPTs design concepts and other studies concerning the subsequent environmental impacts of such installations. Comparisons with other types of solar energy conversion facilities have been also included in this report and suggestions have been provided for making such facilities more sustainable and environmentally friendly. The information will provide a benchmark to position the Next-CSP technology against.

1.2 Introduction

Concentrated solar power (CSP) is a relatively novel concept, which has been developed in order to harvest the solar energy and to transform it other useful forms such as mechanical and electrical energy [22–24]. There are three main concepts of CSP including dish/engine technology [25,26], which has been designed to generate electricity directly, parabolic trough technology [27,28], which has been implemented to produce high pressure superheated steam, and finally solar tower technology (SPT) [29], Figure 1. SPT, also known as solar towers, heliostat power plants, concentrated solar power towers, solar thermal power plants, or central receiver solar power plants, are concentrating solar facilities utilizing a tower designed to receive the directed sunlight. The sunlight concentrating part (called heliostats) consists of a set of sun-tracking mirrors that focus the rays of the sun upon the tower [30]. SPTs are recognized as greenhouse gas (GHG) emission free (or low) facilities, which are highly beneficial towards low-carbon strategy and which are capable of providing dispatchable electricity to the grid [31]. In fact, such systems are the most likely candidates for providing renewable energy in sunny regions to meet the ongoing global need for clean energy resources.

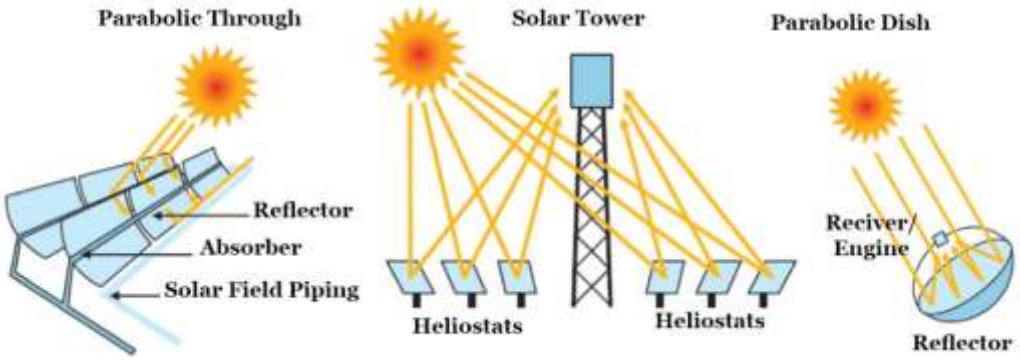

Figure 1. Main CSP systems, adopted from Zhang et al., (2013) [29]**.**

This deliverable first provides a brief description on the different processes (other than the one previously studied), which are employed in order to harvest the solar energy using SPT and then to explore the associated environmental impacts. In this regard, life cycle assessment studies which have been performed so far as well as studies on the environmental consequences of such technologies have been critically reviewed and suggestions for making them more sustainable have been provided and discussed.

1.7 Conclusion

Currently, commercialization of SPTs is among the main priorities of many countries all over the world as a sustainable and low emission energy production technology. In this regard, assessment of the possible environmental consequences of such technologies is of high importance to mitigate such impacts and to promote the commercialization of such technologies to meet the ongoing needs for clean sources of energy. This study provides an overview on the main principals involved in the energy production by solar power towers and the probable environmental impacts through various life cycle stages of such technologies. The results of the study indicated that the environmental impacts from solar tower powers are relatively low compared to those from fossil fuel-based technologies and even from other solar based energy extraction technologies. It can be also concluded that the operation and maintenance phase is the responsible for the majority of the associated environmental impacts. Emission of the greenhouse gases was also identified as the main cause of the environmental pollution created by such technologies. Accordingly, some measures such as adoption of the "renewable for renewable" strategy have also been proposed as the attractive possibilities to minimize the environmental impacts from solar power towers. This study also calls for more studies on the effects of the solar power towers on the local ecosystem and also to perform more socio-economic analysis in order to make such technologies more sustainable to push their commercialization and to meet the ongoing need for the cleaner and renewable sources of energy.